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ABSTRACT

Scaffolding is a form of temporary support offered to a learning to assist in the process of becoming a skilled practitioner. Traditionally, the most common form of learning has been apprenticeship, where a novice learns through active participation in a task, initially only peripherally, and then assuming more control and ownership. Originating in the socio-cultural perspective of Vygotskyan theory and developed by later theorists, the concept of scaffolding has been extended by practical applications in technology-based environments. As the World Wide Web becomes increasingly integrated into the delivery of learning experiences at primary, tertiary and secondary levels, the concept of scaffolding needs to be redefined because it is not readily translated into contexts where the teacher is not present, as in on-line environments. This calls for a reconsideration of the nature of scaffolding and for the alignment of theory with practice. (Contains 26 references.) (Author/AEF)

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Scaffolding : Applications to learning in technology supported environments

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Abstract

Scaffolding is a form of temporary support offered to a learner to assist in the process of becoming a skilled practitioner. Traditionally, the most common form of learning has been an apprenticeship, where a novice learns through active participation in a task, initially only peripherally, and then assuming more control and ownership. Originating in the socio-cultural perspective of Vygotskyan theory and developed by later theorists, the concept of scaffolding has been extended by practical applications in technology-based environments. As the World Wide Web becomes increasingly integrated into the delivery of learning experiences at primary, tertiary and secondary levels, the concept of scaffolding needs to be redefined because it is not readily translated into contexts where the teacher is not present, as in on-line environments. This calls for a reconsideration of the nature of scaffolding and for the alignment of theory with practice.

Introduction: Foundations of scaffolding

The term 'scaffolding' is increasingly used to describe certain kinds of support which learners receive in their interaction with experts, teachers and mentors as they develop new skills, concepts or levels of understanding. The term scaffolding was originally coined by Bruner, Wood & Ross (1976) as a metaphor to describe the effective intervention by a peer, adult or competent person in the learning of another person. Bruner explicitly relates the term scaffolding to Vygotsky's concept of "the zone of proximal development", that is the actual developmental level of the learner compared with the level of potential development that can occur with guidance or collaboration with a more competent person. In technology supported learning environments, the metaphor of scaffolding is appealing in principle, yet elusive and problematic. The appeal of the concept lies in the fact that it directs attention to the role of the instructor or teacher in the learning process, and does so in a way which emphasises that good teaching is necessarily responsive to the state of understanding achieved by particular learners. In earlier research therefore, scaffolded instruction was conceived as a joint interaction in which the teacher and the learner share the responsibility for learning (Vygotsky, 1978; Wood, Bruner & Ross, 1976). In environments mediated by technology, scaffolding can be provided by a tutor or intelligent agent so that learners attain new skills, concepts and knowledge.

Theoretical perspectives on scaffolding: Past and present

It is important to trace the early origins of research on scaffolding in order to appreciate its complexity. The socio-cultural approach emanating from the work of Vygotsky has had a major influence on the development of scaffolded instruction and apprenticeship models of learning (Vygotsky, 1978; Wood & Wood, 1976; Rogoff & Lave, 1984; Collins, Brown & Newman, 1989). Much of this work emphasises the role of social interaction as a cultural amplifier to extend children's cognitive processes, with an adult or expert other introducing learners to the conceptual tools available in society. For cognition to be analysed, culture and context are the fundamental units of consideration, as human development is seen to be located and immersed in social practices. This perspective resists the separation of the individual from society and the daily environment, and perceives meaningful activity as embedded in authentic socially-created situations. This perspective has had profound and far-reaching influences on how current practitioners design learning environments (eg, Jarvela, 1995; Roschelle & Teasley, 1995). Cognitive change can be effected through processes of social interaction in which ideas are articulated, shared, revised, modified and adopted because of their relevance to the cultural context (Roschelle, Levine & Teasley, 1991; Newman, Griffin & Cole, 1989). Learners progress through the ZPD by attempting successive approximations of the learning task, assisted by peers, more able others or with a

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tutor. Support offered in the form of dialogue, discussion and demonstration has been found to be effective in enabling cognitive change (Lave, 1991; Palincsar, 1986).

The mechanisms for assisting learner cognition through the ZPD have been extended greatly by technology applications. Originally, the teachers role was conceived as providing scaffolded assistance through *modelling, contingency management, cognitive structuring* and *feedback* (Tharp & Gallimore, 1988). Through *modelling*, tasks, skills and concepts can be demonstrated while retaining complexity and authenticity, so that learners can become engaged in the acquisition of new skills. *Contingency management* is concerned with recognising and rewarding learner actions, while *feedback* enables students to compare themselves to others. In *cognitive structuring*, learners are assisted to organise their own experiences following the provision of explanations, or meta-level strategies to enable students to organise their own thinking. Later, these mechanisms are internalised and become metacognitive strategies for students to regulate theirs own learning. In addition, verbal scaffolds such as instructing, questioning and cognitive structuring enable students to organise their own activities by suggesting meta strategies that students can acquire so that teacher support becomes " ... a heard, regulating voice, a gradually internalised voices that then becomes the pupil's self-regulating 'still small' instructor." (Tharp & Gallimore, 1988: 57).

Evolving research on scaffolding

Some similarities and differences emerge when we compare recent work on scaffolding with earlier research conducted in the 1980's. For example, much of the work of the Cognition & Technology Group at Vanderbilt (CTGV) has emphasised the notion of anchoring instruction in everyday authentic contexts (CTGV, 1993; 1996). However a major difference is that earlier work (Tharp & Gallimore, 1998; Rogoff & Lave, 1984; Newman, Griffin & Cole, 1989; Wood, Bruner & Ross;1976; Palincsar, 1986) was conducted in face-to face classrooms, where forms of verbal interaction were the most common forms of scaffolding. Teachers and learners occupied the same space, and engaged in learning processes in the social context of a conventional classroom, with its prescribed rules, roles and expectations. This often limited scaffolding to teacher initiated discourse. For example, in many traditional classrooms, questioning has been shown to be a form of social control (Edwards & Westgate, 1994). Many of these social constraints are not present in the virtual classrooms or in contexts where learning is asynchronous. In addition, the nature of scaffolding in such face-to-face classrooms was assumed to be asymmetric in that the teacher was regarded as the expert, and the student the novice. Recent advances in communications technology and in pedagogy envisage an active, participatory role for students, as initiators and co-participant in self-regulating learning process (Brown & Campione, 1994).

A consideration of more recent work in technology-supported environments illustrates how the concept of scaffolding has expanded to include many news forms of support, increased responsibility for students and a fading of the directive of assymetrical aspect of earlier work on scaffolding. While Vygotskyan theory provides the theoretical anchoring needed by making an explicit connection between social interaction and cognitive development, other forms of support can be provided by technology thus enabling learners to engage in cognitive change and skills advancement.

Supporting learning through WWW-based course supports

As the World Wide Web becomes increasingly integrated into the delivery of learning experiences at primary, tertiary and secondary levels, the concept of scaffolding needs to be redefined because it is not readily translated into contexts where the teacher is not present, as in on-line environments. This calls for a reconsideration of the nature of scaffolding and for the alignment of theory with practice (Collis, 1997; 1998). As yet, research focusing on the nature of scaffolds and their functions in specific contexts of learning is limited. Through the provision of examples from a range of contexts where technology is used to mediate the teaching transaction, it is possible to show that the notion of scaffolding offers a way of conceptualising the process of effective learning by:

- reducing the scope for failure in the task that the learner is attempting;
- enabling learners to accomplish a task that they would not be able to achieve on their own;

- bringing learners closer to a state of independent competence.

As technology extends learning beyond the classroom to learning communities, so must roles and concepts of learning and teaching be reconsidered (Collis, 1998). In learning from the WWW, distributed groups of learners can be supported in the learning process by different technological functionalities which support dialogue and interaction (Table 1). With its great potential for collaborative learning, particular forms of scaffolding are needed to provide models, examples and support for the processes of active learning characterised by:

- self-responsibility for thinking and learning,
- awareness of social responsibility;
- thinking and acting scientific processes;
- relating group process and product with professional practice.

Collaborative work can be supported by developing WWW functionalities to support, or scaffold group processes and cognition. Collis (1997) has 're-engineered' academic courses and developed a number of 'tools' to enable group work, sharing of resources, ideas and so that processes and products are integrated. Through a shared work-space environment, students can access texts, documents and other resources, add resources and interacting with others through conferencing facilities. Table 1 displays a number of scaffolding solutions using WWW tools to enable cognitive outcomes and processes that underpin successful learning. In the left column, a list of scaffolds afforded by WWW tools is provided.

Cognitive goal	**WWW Tool**	**Scaffolding afforded by tools**
Reflection Group dialogue Collaboration	Email Bulletin boards	• Group messaging • Discussion forums • Guided reflection
Metacognitive awareness Questioning Self-regulated learning	Frequently asked question space(FAQ)(Hyperlinked access to course resources	• Support for questioning • Collaborative problem solving • Reflection on peer contributions
Group problem solving social interaction Self-responsibility	Groupware & databases Threaded computer conferences	• Shared resources • On line mentors • Management of group processes

Table 1: Examples of scaffolds afforded by WWW functionalities

Some examples of key indicators of effective scaffolding in Web-based environments include:

- the provision of learning resources to help students solve their own problems and share them with others;
- offering multiple channels of communication should enable conversation, exchange of ideas and discussion;
- provision of support for collaborative tasks and development of higher order cognition.

It is advocated that these scaffolding features are built into the design of Web-based courseware, since its activities tend to be less structured that face-to-face instruction, utilising principled design processes (Collis, 1997).

A range of technological approaches to enable scaffolded learning

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Apart from utilising the functionalities of the WWW to support learning, recent research in technology mediated environments presents an array of possibilities and perspectives on scaffolding. By investigating these applications it is possible to compare and extrapolate common features and propose principles for future research. Four examples of scaffolded instructional using hypermedia provide contrasting scenarios for recent interpretations of scaffolded instruction.

Computer supported-intentional learning environments (CSILES)

This approach, conceived by Scardamalia & Bereiter (1989;1992;1993) provides a powerful collaborative medium based on anchored design and discourse space, in which students can negotiate and construct new understandings. In the environment, the teacher's role is transformed from that of manager to facilitator of student collaborative processes. A CSILE is an experimental computer system which can mediate shared spaces for collaborative knowledge building. The basis for this is a shared communal database, which gives students a common space to create and communicate the ideas and representations that emerge from individually and group work. In addition to supporting social interactions needed for shared understanding, it provides facilities required for reaching reciprocal understanding, and facilities for the shared product to be expanded, altered, clarified, elaborated and manipulate for new meanings to emerge. A shared database of text notes and graphics notes allows learners to access and collaborate on the creation of knowledge objects. CSILES have inspired further work and have provided a supportive medium for a number of projects (Cognition and Technology Group at Vanderbilt, 1993).

Intelligent tutoring systems (ITS)

In an intelligent tutoring system, learners are guided through a learning processes and provided with a structures and sequences of task to assist them. Well known examples can be seen in the work of Andersen et al (Anderson, Boyle, Carbett & Lewis, 1990; Anderson, Boyle & Reiser, 1985) is which students are taught to solve algebra word problems, develop programs and generate geometry proofs. By reducing the complexity of the task and providing cognitive structuring, an ITS cam scaffold learning. In an intelligent tutoring system, a learner's progress is charted against an expert model of the process, which the student is expected to model. Intelligent tutoring systems have be criticised for lack of authenticity in the learning task, and for creating tasks where students do not have to engage in real life problem solving (Gudzial & Kehoe, 1998). In ITS environments, collaboration in learning is less essential than in other apprenticeship settings.

Goal-based scenarios (GBS)

Goal-based scenarios are learning setting where students have to engage in an authentic setting where they are presented with a goal to achieve. The objective is for students to acquire and develop the requisite process skills and conceptual knowledge to attain the goal (Schank, 1992). Students are provided with technology-based resources to achieve these goals, and their performance is compared to that of successful model of the process. If a learner cannot achieve the goal, scaffolding is provided in the form of process information which gives corrective feedback in story form to help the learner to address the problem. In a GBS students interact with agents embedded in a system, rather than with socially-based collaborators or peers. BGS are nevertheless unable to provide feedback or support for complex abstract processes where there is no single solution.

Design support environments (DSE's)

Design support environments are aimed at supporting students through a form of software realised scaffolding tailored to assist students engaged in design of software or instruction. In DSE's the environment is simplified by providing a large number of cases, coaching students in the design process and fading the scaffolding (Gudzial, 1998). Instead of providing students with problems, they simply scaffold the design process. A further feature of some DSE's is that they provide adaptive scaffolds, where students can choose or turn off various scaffolds that are not required, thereby fading support.

Conclusion

Examples of each of these forms of technology based scaffolding can be found in the literature cited and each offers a unique perspective on apprenticeship forms of learning, and with the original conception of learning in the zone of proximal development (Collins , Brown & Newman, 1989). While each form of scaffolding provides support, each differs in the level of social support, collaboration with peers and type of feedback offered. Few provide the authenticity that a real apprenticeship offers. Nevertheless, by creating and evaluating scaffolding with technology, researchers are now developing more principled forms of instructional design to guide the process.

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